DESCRIPTION

VIDEO DISPLAY DEVICE AND VIDEO DISPLAY METHOD

TECHNICAL FIELD

The present invention relates to video display devices, and particularly to methods for improving display quality of a video display device having hold-type electro-optical conversion properties, the typical example of which being a liquid crystal display device.

BACKGROUND ART

Display devices which have recently become very popular, of which a typical example is the LCD (liquid crystal display), have found a wide variety of applications including compact mobile terminals and large screen televisions.

Active matrix LCDs and organic EL (electroluminescent) displays differ in electro-optical conversion properties from CRTs (cathode ray tubes). In principle, the former maintain a substantially constant light emission luminance of a display screen throughout one frame of video display. Such a light emission property is referred to as a hold type.

Current challenges are the hold-type driving causing blurs, trailing. and bleeding, which lead to image quality degradation of moving images. Image quality degradation of

an objective to provide a video display device capable of simultaneously reducing motion trailing and disruptive flickering between which there is a tradeoff.

A video display device of the present invention, to solve the problems, is characterized as follows. The device modulates luminances of pixels in accordance with a video signal to display video. The device emits a first light emission component and a second light emission component. The first light emission component accounts for D% of a vertical cycle of the video signal in terms of duration and S% of a light emission intensity of a pixel over the vertical cycle. The second light emission component accounts for (100-D)% of the vertical cycle in terms of duration and (100-S)% of the light emission intensity. An amount of trailing and an amount of flickering are reduced relative to the amounts of trailing and flickering for S = 100 by controlling the first light emission component and the second light emission component so that D and S meet either a set of conditions A: $62 \leq S < 100$, $0 < D < 100$, and $D < S$; or a set of conditions B: $48 < S < 62$, and $D \leq (S-48)/0.23$.

According to the arrangement, D indicates the duty ratio of the first light emission component and that of the second light emission component, while S indicates the light emission intensity ratio. The inventors of the present invention examined the amounts of trailing and the amounts of

ratio D and the light emission intensity ratio S so that D and S meet the set of conditions A or the set of conditions B. Therefore, with the video display device arranged as above, the amount of trailing and the amount of flickering are reduced at the same time.

Another video display device of the present invention, to solve the problems, is characterized as follows. The device modulates luminances of pixels in accordance with a video signal to display video. The device includes video display means setting transmittances of pixels in accordance with the video signal. The device also includes a first light source body emitting intermittent light represented by a pulsed light emission intensity waveform and a second light source body emitting continuous light. The intermittent light accounts for D% of a vertical cycle of the video signal in terms of duration and S1% of a light emission intensity of a pixel over the vertical cycle. The continuous light accounts for (100-D)% of the vertical cycle in terms of duration and (100-S1)% of the light emission intensity. The video display means is illuminated by illumination light obtained by mixing the intermittent light and the continuous light. Light emission of the first light source and the second light source is controlled so as to reduce an amount of trailing and an amount of flickering relative to the amounts of trailing and flickering for S1 = 100.

component and a second light emission component. The first light emission component accounts for D% of a vertical cycle of the video signal in terms of duration and S% of a light emission intensity of a pixel over the vertical cycle. The second light emission component accounts for (100-D)% of the vertical cycle in terms of duration and (100-S)% of the light emission intensity. The device includes average luminance level detect means detecting an average luminance level of the video from the video signal. The value of S or D is changed in accordance with the average luminance level.

Another video display device of the present invention, to solve the problems, is characterized as follows. The device modulates luminances of pixels in accordance with a video signal to display video. The device emits a first light emission component and a second light emission component. The first light emission component accounts for D% of a vertical cycle of the video signal in terms of duration and S% of a light emission intensity of a pixel over the vertical cycle. The second light emission component accounts for (100-D)% of the vertical cycle in terms of duration and (100-S)% of the light emission intensity. The device includes histogram detect means detecting a histogram of the video from the video signal. The value of S or D is changed in accordance with the histogram.

In other words, the optimal amount of trailing and

amount of flickering can be reduced by obtaining information as to whether the screen is bright or dark not only from the amount of motion (interframe differential of the average luminance level) of the video to be displayed, but also from the absolute value of the average luminance level and the histogram of luminance distribution.

Another video display device of the present invention, to solve the conventional problems, is characterized as follows. The device modulates luminances of pixels in accordance with a video signal to display video. The device emits a first light emission component and a second light emission component. The first light emission component accounts for D% of a vertical cycle of the video signal in terms of duration and S% of a light emission intensity of a pixel over the vertical cycle. The second light emission component accounts for (100-D)% of the vertical cycle in terms of duration and (100-S)% of the light emission intensity. D and S meet either a set of conditions A: $62 \leq S < 100$, $0 < D < 100$, and $D < S$; or a set of conditions B: $48 < S < 62$, and $D \leq (S-48)/0.23$. An amount of trailing and an amount of flickering for $S = 100$ are simultaneously reduced by controlling the first light emission component and the second light emission component so that $D/2 \leq P \leq (100-D/2)$, and $0 < D < 100$, where P is a ratio in percentages of a duration to the vertical cycle, the duration beginning at a start of the vertical cycle and ending at a

CLAIMS

1. (Amended) A video display device modulating luminances of pixels in accordance with a video signal to display video,

said device emitting a first light emission component and a second light emission component, the first light emission component accounting for D% of a vertical cycle of the video signal in terms of duration and S% of a light emission intensity of a pixel over the vertical cycle, the second light emission component accounting for (100-D)% of the vertical cycle in terms of duration and (100-S)% of the light emission intensity,

wherein an amount of trailing and an amount of flickering are reduced relative to the amounts of trailing and flickering for S = 100 by controlling the first light emission component and the second light emission component so that D and S meet either a set of conditions A:

$62 \leq S < 100$, $0 < D < 100$, and $D < S$, or

a set of conditions B:

$48 < S < 62$, and $D \leq (S-48)/0.23$.

2. The video display device of claim 1, comprising:

video display means setting transmittances of pixels in accordance with the video signal; and

a light source body illuminating the video display means,

19. The video display device of claim 18, wherein the intermittent light and the continuous light have a light emission intensity set to a level perceivable by the human eye.

20. The video display device of any one of claims 1 through 19, comprising scene change detect means detecting an amount of scene change in the video from the video signal,

wherein a value of S or D is changed in accordance with the amount of scene change.

21. (Amended) The video display device of any one of claims 1 through 19, comprising <u>average luminance level detect means</u> detecting an average luminance level in the video from the video signal,

wherein a value of S or D is changed in accordance with the average luminance level.

22. The video display device of claim 1, comprising:

video display means setting transmittances of pixels in accordance with the video signal; and

a light source body illuminating the video display means,

wherein:

the light source body is disposed separated from the

accordance with the video signal; and

a first light source body emitting intermittent light represented by a pulsed light emission intensity waveform and a second light source body emitting continuous light, the intermittent light accounting for D% of a vertical cycle of the video signal in terms of duration and S1% of a light emission intensity of a pixel over the vertical cycle, the continuous light accounting for (100-D)% of the vertical cycle in terms of duration and (100-S1)% of the light emission intensity,

wherein:

the video display means is illuminated by illumination light obtained by mixing the intermittent light and the continuous light; and

light emission of the first light source and the second light source is controlled so as to reduce an amount of trailing and an amount of flickering relative to the amounts of trailing and flickering for S1 = 100.

45. The video display device of claim 44, further comprising:

first light source body drive means controlling ON/OFF of the first light source body; and

second light source body drive means controlling ON/OFF of the second light source body.

46. The video display device of claim 45, wherein the first

53. The video display device of claim 52, wherein at least either one of the first light source body and the second light source body is a semiconductor light emitting element.

54. The video display device of claim 53, wherein the semiconductor light emitting element is a light emitting diode.

55. The video display device of claim 52, wherein the second light source body is a cold cathode fluorescent lamp.

56. (Cancelled)

57. (Cancelled)

58. (Cancelled)

59. (Cancelled)

60. (Amended) The video display device of any one of claims 1 through 19, comprising histogram detect means detecting a histogram of the video from the video signal,

wherein a value of S or D is changed in accordance with the histogram.

61. (Amended) A video display device modulating luminances

of pixels in accordance with a video signal to display video,

said device emitting a first light emission component and a second light emission component, the first light emission component accounting for D% of a vertical cycle of the video signal in terms of duration and S% of a light emission intensity of a pixel over the vertical cycle, the second light emission component accounting for (100-D)% of the vertical cycle in terms of duration and (100-S)% of the light emission intensity,

wherein:

D and S meet either a set of conditions A:

$62 \leq S < 100$, $0 < D < 100$, and $D < S$; or

a set of conditions B:

$48 < S < 62$, and $D \leq (S-48)/0.23$;

an amount of trailing and an amount of flickering for S = 100 are simultaneously reduced by controlling the first light emission component and the second light emission component so that $D/2 \leq P \leq (100-D/2)$, and $0 < D < 100$,

where P is a ratio in percentages of a duration to the vertical cycle, the duration beginning at a start of the vertical cycle and ending at a midpoint of a light emission period associated with the first light emission component.

62. The video display device of claim 61, wherein

$P = 50 + K$ for $\leq K \leq (50-D/2)$,

where K is a constant dictated by a response time constant of the video display means.

63. (Cancelled)

of the video signal to enable the pixel to achieve a light emission waveform representing light emission constituted by the first light emission component and the second light emission component.

75. The video display device of any one of claims 61 through 63, comprising:

video display means setting transmittances of pixels in accordance with the video signal; and

a light source body illuminating the video display means,

said device further comprising light control means, disposed in an optical path provided between the video display means and the light source body, controlling an illumination light intensity of the light source body to control P.

76. (New) A video display method including modulating luminances of pixels in accordance with a video signal to display video,

said method comprising emitting a first light emission component and a second light emission component, the first light emission component accounting for D% of a vertical cycle of the video signal in terms of duration and S% of a light emission intensity of a pixel over the vertical cycle, the

second light emission component accounting for (100-D)% of the vertical cycle in terms of duration and (100-S)% of the light emission intensity,

wherein an amount of trailing and an amount of flickering for S = 100 are reduced by controlling the first light emission component and the second light emission component so that D and S meet either a set of conditions A:

$62 \leq S < 100$, $0 < D < 100$, and $D < S$, or

a set of conditions B:

$48 < S < 62$, and $D \leq (S-48)/0.23$.

ratio D and the light emission intensity ratio S so that D and S meet the set of conditions A or the set of conditions B. Therefore, with the video display device arranged as above, the amount of trailing and the amount of flickering are reduced at the same time.

Another video display device of the present invention, to solve the problems, is characterized as follows. The device modulates luminances of pixels in accordance with a video signal to display video. The device includes video display means setting transmittances of pixels in accordance with the video signal. The device also includes a first light source body emitting intermittent light represented by a pulsed light emission intensity waveform which is in synchronism with a vertical synchronization signal of the video signal and a second light source body emitting continuous light. The intermittent light accounts for D% of a vertical cycle of the video signal in terms of duration and S1% of a light emission intensity of a pixel over the vertical cycle. The continuous light accounts for the entire vertical cycle in terms of duration and (100-S1)% of the light emission intensity. The video display means is illuminated by illumination light obtained by mixing the intermittent light and the continuous light. Light emission of the first light source and the second light source is controlled so as to reduce an amount of trailing and an amount of flickering relative to the amounts of

accordance with the video signal; and

a first light source body emitting intermittent light represented by a pulsed light emission intensity waveform which is in synchronism with a vertical synchronization signal of the video signal and a second light source body emitting continuous light, the intermittent light accounting for D% of a vertical cycle of the video signal in terms of duration and S1% of a light emission intensity of a pixel over the vertical cycle, the continuous light accounting for the entire vertical cycle in terms of duration and (100-S1)% of the light emission intensity,

wherein:

the video display means is illuminated by illumination light obtained by mixing the intermittent light and the continuous light; and

light emission of the first light source and the second light source is controlled so as to reduce an amount of trailing and an amount of flickering relative to the amounts of trailing and flickering for S = 100.

45. The video display device of claim 44, further comprising:

first light source body drive means controlling ON/OFF of the first light source body; and

second light source body drive means controlling ON/OFF of the second light source body.